

# **Energy efficiency in new housing**

– a guide to achieving best practice



2001 EDITION



**HOUSING  
ENERGY EFFICIENCY**

**BEST PRACTICE  
PROGRAMME**



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## 1 INTRODUCTION

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Housing associations and private developers are jointly responsible for meeting the government's target of constructing approximately 4.4 million homes between 1991 and 2016. If widely adopted, new housing built using the principles of energy-efficient design will minimise the environmental impact by making a substantial contribution to reducing the UK's carbon dioxide (CO<sub>2</sub>) emissions in the 21st century.

The aim of this Guide is to help housebuilders design and build new energy-efficient homes that, at little or no extra cost, can achieve standards of energy efficiency beyond the current Building Regulations. For external walls two levels of insulation standards are given. 'Level two' should be used whenever possible, with 'level one' being used only when the higher standard cannot be achieved.

The recommendations are based on many years of experience and research into low-energy construction. The guidance allows designers and builders to adopt or adapt these standards. The Guide provides answers to some common queries and concerns. These include:

- how energy efficient?
- what is cost-effective?
- how can I avoid problems?
- what are the options I can use?
- where do I go for more information?

### THE BENEFITS OF AN ENERGY-EFFICIENT PACKAGE

An energy-efficient approach is one which promotes an integrated package of energy efficiency measures. It can be applied to all new designs, leading to levels of energy efficiency beyond that of current Building Regulations. An energy-efficient house can still be conventional in appearance.

Calculation and display of an energy rating using the Government's Standard Assessment Procedure (SAP) is not only a requirement of the Building Regulations, but it can also be used by housebuilders to demonstrate to prospective purchasers that a high level of energy efficiency has been achieved. People looking to rent or buy can then use SAP to compare the energy efficiency of different designs.

The higher standards of insulation suggested in this Guide as part of an energy-efficient package can be used, therefore, to market new homes to an increasingly environmentally aware public.

### MINIMISING THE COSTS OF ENERGY EFFICIENCY

It has been demonstrated through projects with different designs, different floors and wall constructions, and different tendering and contracting methods, that the cost of energy-efficient construction can be kept to a minimum by:

- ensuring an integrated package of energy-efficient measures
- assessing the costs and benefits of different energy-saving features
- carefully choosing designs and constructions
- including the required energy measures in the specification, rather than pricing as extras.

## INTRODUCTION

**REDUCING FUEL BILLS WITH HIGHER STANDARDS**

A higher standard of insulation, especially when combined with a more energy-efficient heating package, will significantly reduce fuel bills for the occupants. In most situations higher standards can be achieved for little or no extra cost. Examples of the insulation packages, combined with gas-fired central heating, are given below.

An example of the higher standard using gas-fired central heating:

- walls – U-value 0.30 to 0.20 W/m<sup>2</sup>K
- pitched roof – U-value 0.16 W/m<sup>2</sup>K
- ground floor – U-value 0.20 W/m<sup>2</sup>K
- double-glazed windows with low-emissivity (low-e) glass with 16 mm or larger air gap – U-value 2.00 W/m<sup>2</sup>K
- all doors and windows draughtstripped
- high efficiency boiler (Bands A to C)
- high-performance hot water cylinder with cylinder thermostat (not if combi system)
- seven-day programmable room thermostat with domestic hot water time control
- TRVs on all radiators except in rooms with room thermostat
- weather compensation and separately timed zone control for larger houses.

Typical SAP ratings:

- small flat = 100 to 109\*
- detached house = 102.

\*The lower figure is for a ground-floor flat; the higher figure for a mid-floor flat.

## Housing associations

*The higher level of energy efficiency achieved by adopting a package of measures will save occupants money in reduced fuel bills, an important concern to housing associations.*

## Private developers

*A number of private developers have already found that energy efficiency is a powerful tool for marketing new housing, particularly when sales staff are fully briefed on all aspects of energy efficiency.*

**CARBON INDEX (CI)**

The CI is based on the CO<sub>2</sub> emissions associated with space and water heating, but adjusted for floor area so that it is essentially independent of dwelling size for a given built form. It is expressed on a scale of 0.0 to 10.0 – the higher the number, the better the performance.

## 2 INTEGRATED DESIGN

### WHAT IS INTEGRATED DESIGN?

An energy-efficient property must be designed so that the orientation, layout, insulation, heating and ventilation systems work together. With adequate temperatures and ventilation levels, an integrated design maximises cost effectiveness in construction and minimises fuel costs. Within each of these areas, the integrated approach should also be applied.

#### Orientation

At the initial design stages, dwellings should be positioned, where possible, to take maximum advantage of solar gains, daylighting and any existing protection from the wind (see Section 3).

#### Layout

To maximise passive solar gain, the dwellings should be planned internally so that main living rooms are on the south side and service rooms to the north (see Section 3).

#### Carbon Index (CI)

The CI is based on the CO<sub>2</sub> emissions associated with space and water heating, but adjusted for floor area so that it is essentially independent of dwelling size for a given built form. It is expressed on a scale of 0.0 to 10.0 – higher the number the better the performance.

#### ECOHOMES

EcoHomes considers the broad environmental concerns of climate change, resource use and impact on wildlife, but balances these against the need for a high quality, safe and healthy internal environment.

To obtain the CI for a dwelling the appropriate section of the SAP worksheet (version 9.7 or later) is completed.

For an average three-bedroom semi-detached dwelling heated by gas central heating and built to 2002 Building Regulations insulation standard would have a CI of around 8.0.

#### Ventilation

Ventilation should be through intentional openings that can be controlled by the occupants (such as trickle ventilation and extract fans). Care should be taken to seal unintentional ventilation paths (such as leaks around openings for service pipes and cables) (see Section 5).

#### Heating

Heating systems must be correctly sized for the actual heat loss from the house (with allowance for warm-up). Oversizing is likely to waste energy. Undersizing will lead to substandard temperatures. Heating controls must be able to respond to incidental and solar gains and to provide adequate heating in all parts of the house (see Section 6).

#### Environmental effects

In addition to energy efficiency considerations, assessment should be made, at an early stage in the design process, of the environmental impact of the project.

EcoHomes, the housing version of the BRE Environmental Assessment Method (BREEAM), is an increasingly recognised mark of environmental quality for housebuilders. It is based on useful checklists of environmental factors, which, if taken into account, can enhance the quality of the design.

For example, building materials and specifications are chosen to minimise environmental impacts. A reference guide, 'The Green Guide to Housing Specification' presents this information on a simple A-C scale. This score then forms part of the EcoHomes assessment.

For details of the other topics covered by the EcoHomes assessment, refer to Appendix A1.

## Housing associations

*Incorporating the principles of integrated design into the specification at an early stage in the procurement process will help optimise the long-term energy performance of the project.*

## Private developers

*Well co-ordinated detailing can result in fewer site problems.*

## INTEGRATED DESIGN

**DEVELOPING A PACKAGE OF ENERGY EFFICIENCY MEASURES**

By combining either 'level one' or 'level two' insulation standards, housebuilders can produce a more energy-efficient specification.

Housebuilders need to establish, for a particular house type, which package of measures is practicable and suitable for inclusion in their design specification.

Designers wishing to adapt the standard packages need to agree on a series of targets covering, for example, energy use, running costs and CO<sub>2</sub> emissions. This is best done by a calculation (usually a computer program) based on the BRE Domestic Energy Model (BREDEM). The calculation can:

- check heat loss through each element of the fabric
- check ventilation heat loss
- apply incidental heat gains from occupants, lighting and appliances, solar gains, etc
- apply heating-system efficiencies based on particular types of equipment and controls.

The Standard Assessment procedure (SAP), an energy rating for housing, is based on BREDEM and takes into account space and water heating costs. It is expressed on a scale from 1 for a very inefficient home to 100 (SAP 98) or 120 (SAP 2001\*) for one that is energy efficient.

A SAP rating is required under Building Regulations for all new dwellings, and is the government's preferred energy rating.

## Housing associations

*BREDEM provides fuel-bill estimates which can be compared with tenants' ability to pay.*

*The SAP rating system can provide a useful benchmarking tool to ensure that the aim of low-energy housing procurement is maintained.*

## Private developers

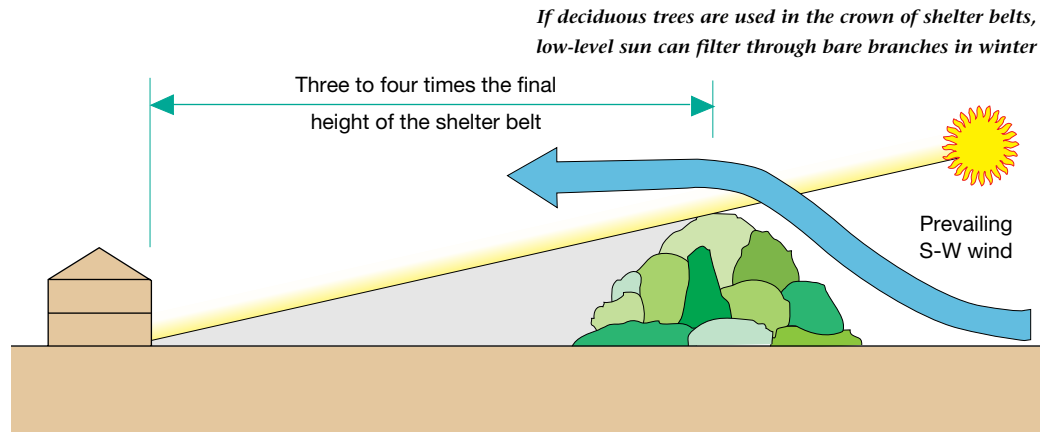
*The SAP rating system gives potential housebuyers an immediate reference point from which to judge your product favourably.*

Although the SAP does not give fuel-use estimates, it allows housebuilders to compare the energy efficiency of different designs. It can be used as the basis for choosing energy efficiency standards higher than those of the current Building Regulations. Organisations such as the Housing Corporation have for many years set minimum and recommended SAP ratings for new build and dwellings undergoing refurbishment.

If required, a number of energy-labelling organisations can undertake SAP ratings on behalf of housebuilders. For details, see Appendix A3.

\* SAP 2001 (BREDEM V9.70) comes into force on 4th March 2002 (Scotland) and 1st April 2002 (England and Wales).

### 3 PASSIVE SOLAR DESIGN



#### OPPORTUNITIES FOR PASSIVE SOLAR DESIGN

Sunlight through windows is a useful source of energy for houses and can reduce the need for conventional heating. Simple design techniques to utilise sunlight can be applied at both the estate layout and individual house planning design stages of a housing scheme (see below).

Both local climate and microclimate affect energy use, for example:

- lower temperatures in the north of Britain increase heat loss
- winds on exposed sites reduce temperatures and increase ventilation heat loss
- shaded sites can reduce 'solar gain' and increase the use of space heating.

Passive solar design can save energy and increase thermal comfort as follows.

- Attention to site layout and window design can reduce space heating demand by up to 10%, compared with an average new dwelling.
- A well-designed passive solar dwelling not only saves energy but also contributes to a pleasant environment by providing warm and naturally lit living-rooms.
- Passive solar design does not add to house or estate build costs. Some sites, however, will not be suitable for passive design due to access limitations and/or overshadowing.

#### Site layout

- Arrange dwellings so that living-rooms and major bedrooms are within 45° of south.
- Avoid overshadowing within 30° of south.
- Space dwellings in England and Wales more than twice their height apart (north to south), and dwellings in Scotland more than three times their height apart.
- Place buildings of lesser height, eg bungalows, on the south edge and taller buildings, eg three-storey dwellings, on the north of the site to increase solar gain access.

#### PASSIVE SOLAR HOUSING

Some general considerations are:

- design first for minimal heat loss and then consider solar improvements
- use a reasonably compact plan to minimise the exposed surface area
- use garages to shelter north elevations
- use enclosed draught lobbies.

#### Internal layout

- Avoid large ventilated entrances and stairs in blocks of flats; they introduce a cold area into the middle of the block.
- Locate the main living-rooms on the south side, since they are used more often and generally need higher room temperature than other rooms.

# Private developers

*Good estate layout produces warm, sunny houses and gardens that are liked by housebuyers.*

## PASSIVE SOLAR DESIGN

- Where possible, place stairs, halls, kitchens, storerooms and bathrooms on the north side.
- Avoid stairs that rise directly from the living-room.

**Window locations and sizes**

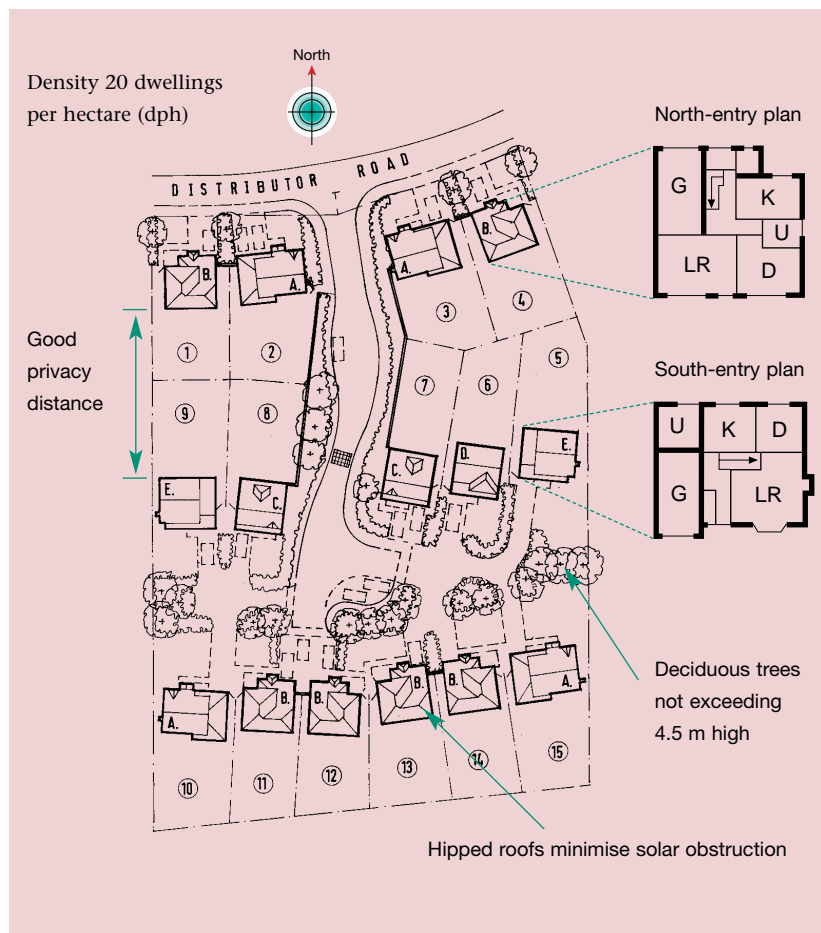
- Orientate houses so that their main glazed elevation is preferably within 30°, but no more than 45° of south.
- Increase the proportion of south-facing glazing without increasing the total glazed area.
- South-east-facing windows have the benefits of admitting sun in the morning before ambient temperatures have risen, compared with south-west-facing windows that admit afternoon sun, which may lead to overheating.

**Heating**

Where necessary, design heating systems and controls to respond to solar gain. Rooms subject to high solar gain should have their own zone temperature control (eg thermostatic radiator valves).

**General design notes**

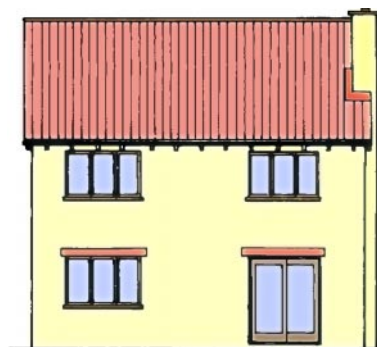
- *Maintain privacy in rooms with larger than average windows, otherwise net curtains will eliminate solar gains.*
- *Conservatories are not recommended as an energy-saving measure.*



*Part of an estate layout showing north-entry and south-entry plans. Varying the orientation of the houses from due south by up to 20° gives interest and informality*

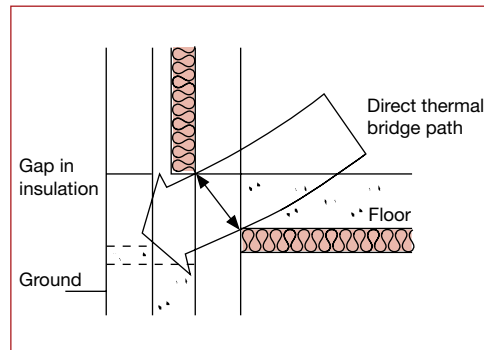
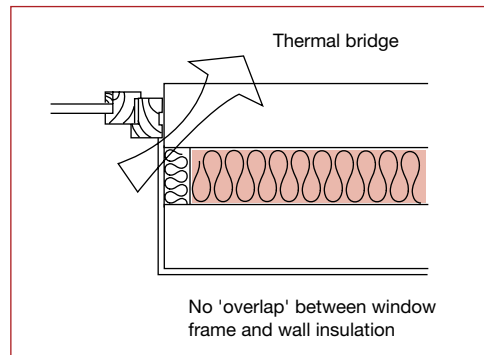
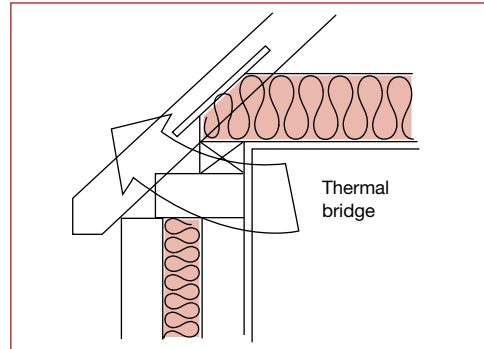
**Front (north) elevation windows to:**

- kitchen
- entrance hall and WC
- two small bedrooms
- bathroom

**South elevation windows to:**

- living-room
- dining room
- two main bedrooms

## 4 INSULATION STANDARDS AND CONSTRUCTION



*Examples of thermal bridges*

### INSULATION, HEATING AND VENTILATION WORKING TOGETHER

This section shows how insulation standards above those of the current Building Regulations can be achieved for various construction types. Levels 'one' and 'two' are shown for wall constructions, and a single standard is given for both floor and roof constructions. 'Level two' should be used whenever possible.

All exposed and semi-exposed elements of the dwelling should be insulated to produce an all-round integrated insulation package. This will minimise heat loss in the most cost-effective way. When combining options, ensure continuity of insulation to avoid thermal bridges. Thermal bridging occurs when all the main elements of the structure are insulated, but there are local poorly insulated pathways from the inside to the outside of the building.

Thermal bridges may be significant in heat-loss terms (up to 10% in a highly insulated dwelling), but, by creating cold spots, they are equally important in terms of condensation and the discolouration of decorations. Thermal bridges are most likely to occur around windows and doors, and at the junctions between external walls and floors or roofs. Detailed guidance for designers on minimising thermal bridging in new housing can be found in 'Thermal insulation: avoiding risks' (2002 edition), and 'Limiting thermal bridging and air leakage: Robust construction details for dwellings and similar buildings' (see Appendix A4 for details).

All housing projects should be assessed for energy efficiency using SAP as described in Section 2.

### ENVIRONMENTAL NOTES

To reduce the impact of a building, specifiers should avoid foam insulation materials which use hydrochlorofluorocarbons (HCFCs) as blowing agents unless there is no other environmental alternative available. These gases have powerful greenhouse and ozone-depleting properties that contribute to global warming. Where material strength is required, specify rigid foam products that use less damaging blowing agents. For best overall environmental performance, look to cork, cellulose, rock-wool and low-density glass-wool.

## INSULATION STANDARDS AND CONSTRUCTION

### EXTERNAL WALLS

A range of construction methods can be used to build external walls to insulation standards above those set by the Building Regulations. A selection of these are described on pages 12 and 13.

#### Full-fill cavity walls

In addition to reducing heat loss, increasing the thickness of insulation provides additional resistance to rain penetration. Fully filled cavities can be used anywhere, although protection may be required in the most severely exposed parts of the country. Housebuilders or designers should check with warranty bodies on those areas where additional protection, for example to gable walls, is necessary.

#### Partial-fill cavity walls

A minimum 50 mm clear residual cavity is required for all constructions that are not fully filled. Consequently, walls with partially filled cavities may need to be wider than those with fully filled cavities to give the same level of insulation.

#### Externally insulated walls

Walls can be insulated externally using insulation in the form of sheets or batts, finished with a weatherproof covering, such as tile hanging or rendering. Since rendering on external insulation can be subject to wide fluctuations in temperature, reinforcement and appropriate movement joints are required. A light-coloured render that minimises temperature build-up is preferred.

### General design notes

*Air movement behind insulation, through gaps in the inner leaf and behind plasterboard can significantly increase energy use. These airpaths need to be sealed at the time of construction. The correct application of dry-lining is critical.*

### Timber-frame walls

Timber-frame construction offers the opportunity of building-in substantial thicknesses of insulation. The insulation usually fills the depth of the timber-frame structure, but additional layers can be added behind the plasterboard lining or as insulated sheathing.

The frame should have a vapour-control layer on the warm side of the insulation and a breather membrane on the outside of the sheathing.

### Insulation thickness

The thickness of insulation needed to achieve a particular U-value depends on the thermal properties of the structure and the insulation.

In the examples on pages 12 and 13, the minimum thermal resistance,  $R$  ( $\text{m}^2 \text{K/W}$ ), that must be provided by the insulation is shown for each form of construction, for each U-value.

Also shown in tabular form is the minimum thickness of insulation needed to achieve the stated thermal resistance for a range of representative thermal conductivity ( $\lambda$ ) values.

Since the thermal properties of individual products vary, conductivity values should be checked with manufacturers. These values can then be used to calculate the minimum insulation thickness, as follows:

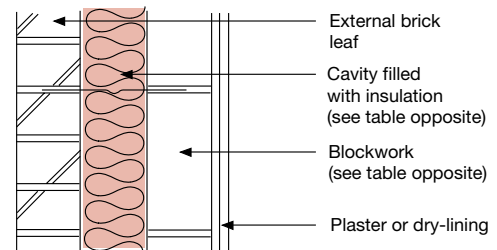
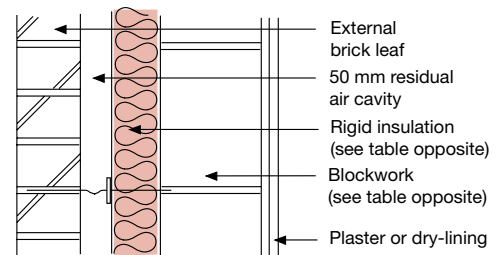
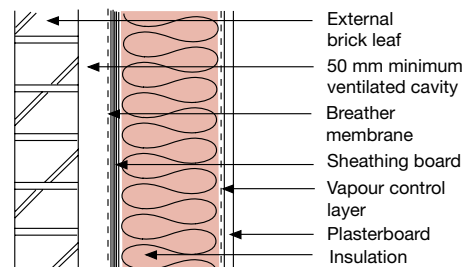
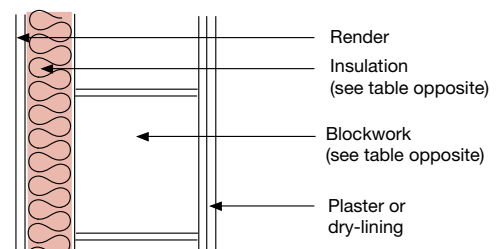
$$t[\text{mm}] = \frac{R \times \lambda}{0.001}$$

where:

$R$  = the required thermal resistance of the insulation in  $\text{m}^2 \text{K/W}$

$\lambda$  = the thermal conductivity of the insulation in  $\text{W/mK}$ .

## INSULATION STANDARDS AND CONSTRUCTION – EXTERNAL WALLS

**Full-fill****Partial fill****Timber frame****Externally insulated blockwork**

## INSULATION STANDARDS AND CONSTRUCTION – EXTERNAL WALLS

Standard	Level 1 (U-value = 0.3 W/m <sup>2</sup> K)	Level 2 (U-value = 0.2 W/m <sup>2</sup> K)
Block inner leaf	Lightweight	Ultra lightweight
Block $\lambda$ value	0.16	0.11
Block thickness (mm)	100	100
R <sub>req</sub> of insulation	2.22	3.72
<b>Insulation <math>\lambda</math> value</b>	Minimum thickness	Minimum thickness
0.035	78	130
0.040	89	149

- Specify stop ends to all cavity trays.
- Avoid raked joints.
- Specify weepholes over openings.

Standard	Level 1 (U-value = 0.3 W/m <sup>2</sup> K)	Level 2 (U-value = 0.2 W/m <sup>2</sup> K)
Block inner leaf	Lightweight	Ultra lightweight
Block $\lambda$ value	0.16	0.11
Block thickness (mm)	140	140
R <sub>req</sub> of insulation	1.96	3.33
<b>Insulation <math>\lambda</math> value</b>	Minimum thickness	Minimum thickness
0.020 (foil-faced)	35	62
0.025	49	84
0.030	59	100
0.035	68	117
0.040	78	133

- Specify a 50 mm minimum clear residual air cavity.
- Specify drips on wall ties to be in the centre of the residual air cavity.
- Hold insulation boards against inner leaf with retaining clips; avoid gaps between the boards.

Standard	Level 1 (U-value = 0.3 W/m <sup>2</sup> K)	Level 2 (U-value = 0.2 W/m <sup>2</sup> K)
R <sub>req</sub> of insulation*	3.5	5.7
<b>Insulation <math>\lambda</math> value</b>		
0.035-0.040	140 mm studs Frame cavity filled with insulation	235 mm studs or timber I beams Frame cavity filled with insulation

\*Assumes timber fraction of 0.15

- Do not fill the ventilated cavity with insulation.
- Specify a vapour-control layer, to be installed on the warm side of the insulation.
- Avoid services perforating the vapour-control layer or, if they do, fully seal all holes.
- Specify non-combustible insulation.
- Specify an insulation thickness no greater than actual timber dimensions to avoid compressing the insulation.

Standard	Level 1 (U-value = 0.3 W/m <sup>2</sup> K)	Level 2 (U-value = 0.2 W/m <sup>2</sup> K)
Block inner leaf	Lightweight	Ultra lightweight
Block $\lambda$ value	0.16	0.11
Block thickness (mm)	190	215
R <sub>req</sub> of insulation	1.86	3.00
<b>Insulation <math>\lambda</math> value</b>	Minimum thickness	Minimum thickness
0.020	38	60
0.025	47	75
0.030	56	98
0.035	65	104
0.040	75	120

- Reinforce render with mesh.
- Provide movement joints compatible with the system.
- Use a light-coloured finish to minimise heat build-up.
- Use a render incorporating a polymer and/or fibres.

## INSULATION STANDARDS AND CONSTRUCTION – FLOORS

## General design notes

- Lap the floor dpm with the wall damp-proof course.
- Specify moisture-resistant flooring grade plywood or chipboard and allow for expansion at the floor edges.
- Take care when positioning the dpm in relation to its compatibility with expanded polystyrene insulation and likely slab drying times.

## FLOORS

Heat loss through ground floors depends on the size and shape of the floor as well as the type and conductivity of the ground below the floor. Insulation of 125 – 150 mm thickness gives a good level of insulation for most floor types.

This level of insulation will generally achieve a U-value of approximately 0.20 W/m<sup>2</sup>K for terraced and detached properties.

However, the actual U-value depends on the type of floor construction, insulation, and floor perimeter to area (P/A) ratio. Some common floor constructions are shown below.

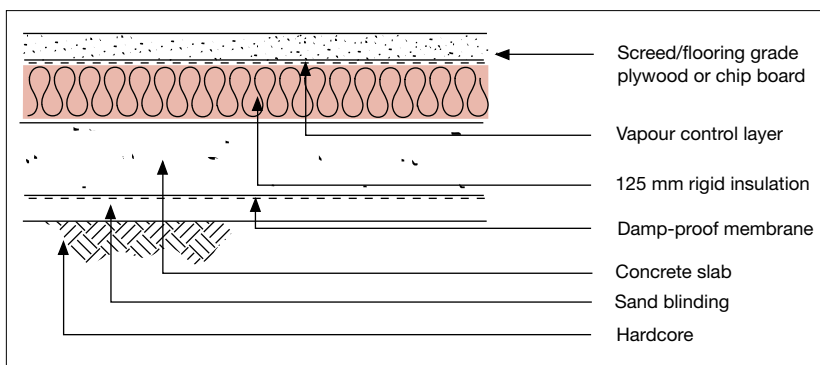
## Services

- PVC cables should be separated from polystyrene insulation, using ducts or protective cover strips to avoid degradation of the PVC.
- Maintain insulation around and over services.
- Ensure the damp-proof membrane (dpm) is sealed around pipes and other services.

Minimum thickness (mm) of insulation for floors with P/A ratio from 0.20 to 1.00						
Insulation $\lambda$ value	Solid concrete floors			Suspended timber floors		
	P/A = 0.2	P/A = 0.6	P/A = 1.0	P/A = 0.2	P/A = 0.6	P/A = 1.0
0.020	46	75	81	82	118	127
0.030	69	112	121	107	153	164
0.040	92	149	162	132	188	200

Thickness of insulation required to achieve a U-value of 0.20 W/m<sup>2</sup>K

## Insulation above ground-supported slab

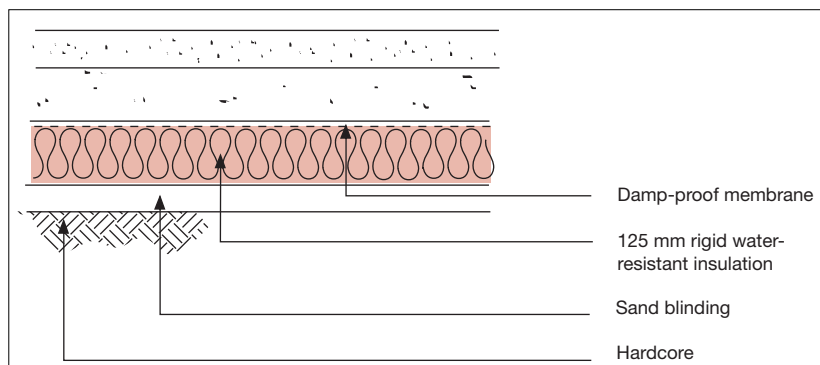


- Specify that the screed should be 65 mm thick.
- Where the dpm is placed below the slab, lay a vapour control layer of 500 g polyethylene above the insulation.
- Alternatively, place the dpm above the slab.
- Add a separating layer between the screed and fibrous insulation.
- Ensure the surface of the concrete is clean and free from mortar or plaster droppings.
- Specify flatness tolerance of 5 mm under a 3 m straight edge.
- Lay a vapour-control layer below the insulation for composite flooring and below the floor boarding when the insulation is laid separately.

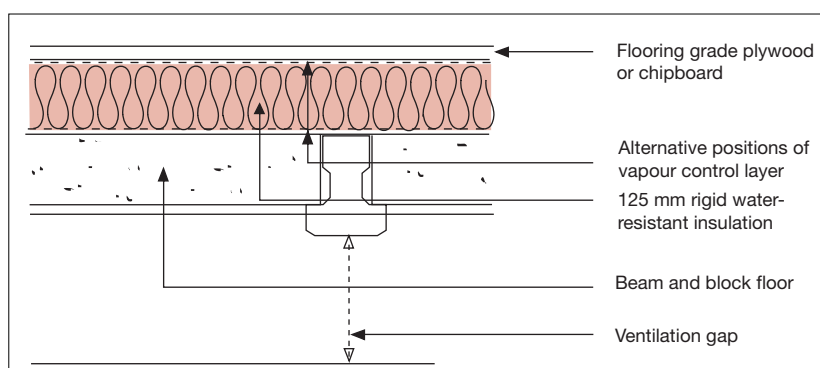
## INSULATION STANDARDS AND CONSTRUCTION – FLOORS

### Insulation below ground-supported slab

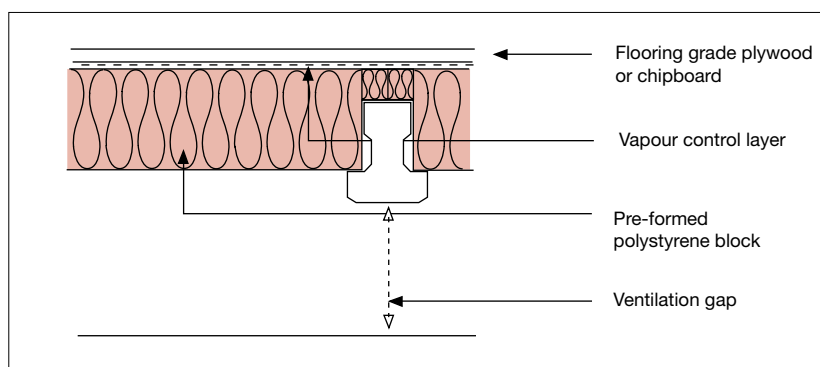
- The insulation needs to be waterproof with sufficient compressive strength.
- Ensure at least 25 mm insulation is provided to perimeter of slab.



### Insulation above proprietary beam and block floor

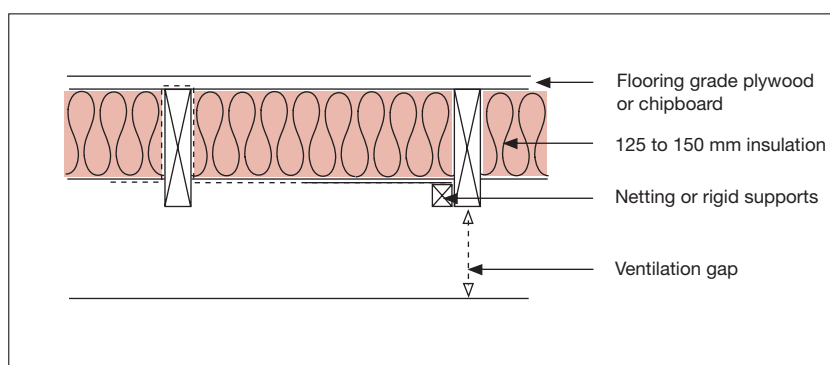


### Proprietary beam and polystyrene block suspended floor



### Suspended timber floors (insulation between joists)

- Specify draughtstripping at the edge of the floor.
- Ensure insulation is continued to edge of floor.
- Do not specify vapour control layer; it can trap spilt water.
- Make sure the underfloor space is well ventilated.



## INSULATION STANDARDS AND CONSTRUCTIONS – ROOFS

## General design notes

## Cold roofs

- Specify loft hatches, with 150 mm fixed insulation and draughtstripping.
- Avoid recessed light fittings in ceilings below the roof space as they cannot be easily sealed.

## Warm roofs

- Avoid problems of insulating tanks and pipes in a cold loft space.
- Careful detailing required at eaves.

## ROOFS

## Insulation

For both pitched roofs with lofts (cold roof) and pitched roofs with 'sarking' insulation (warm roof) the insulation is best laid in two layers, one between the joists or rafters, the second across to reduce thermal bridging. A minimum U-value of 0.16 W/m<sup>2</sup>K should be achieved, although increasing the insulation thickness involves small additional cost, especially in cold roof construction.

## Avoid condensation

Care must be taken in the design and construction of roofs to avoid condensation and thermal bridging. For cold roofs, ventilation of the loft space will ensure the dispersion of moisture and prevent condensation.

## Services

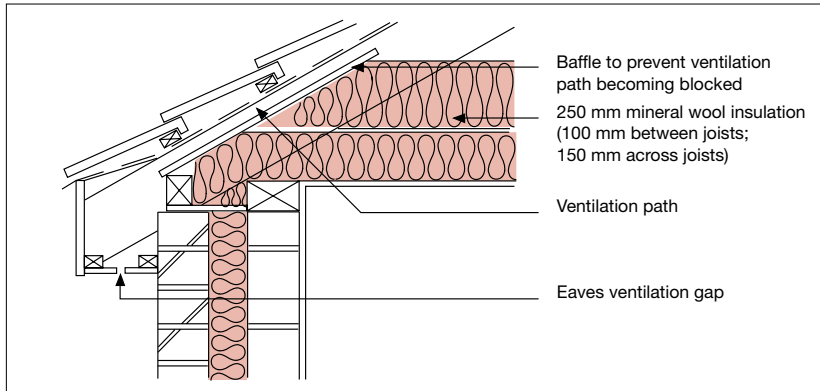
- Seal any holes around services, especially those from kitchens, bathrooms and airing cupboards.

- Keep electrical cables above the insulation to avoid overheating (cold roof only).
- Where practical, avoid placing tanks and pipes in the roof to remove risk of freezing. Any pipes or tanks located in the roof space must be insulated. Omit insulation from directly under the tank to allow warm air to reach its base (cold roof only).

## Construction notes

## Pitched roofs (cold)

- Provide a ventilation gap at the eaves with a 3-4 mm mesh to prevent entry of insects. Its area is dependent on the pitch of the roof.
- Provide additional ventilation openings at the ridge to cross-ventilated roofs if pitch is less than 15° or where the ceiling follows the pitch of the roof.
- Complex low pitched roofs, single pitched roofs and roofs with spans exceeding 10 m may need extra ventilation.
- Extra joists at right angles to the ceiling joists are needed to support boarding to access ways, eg to tanks.



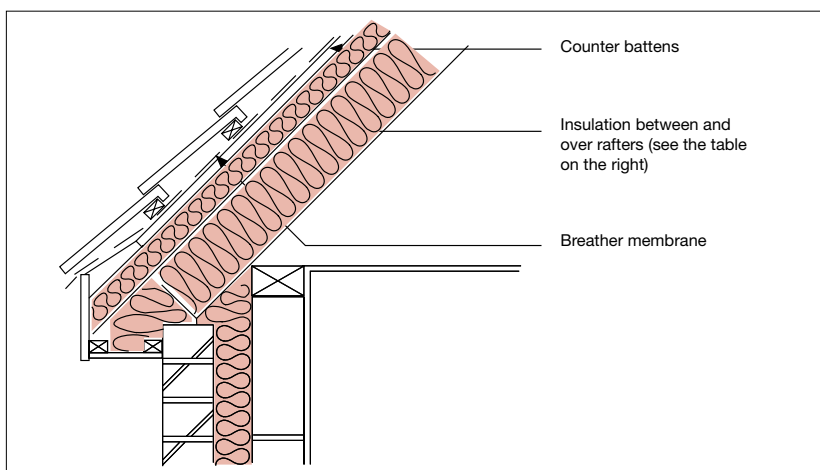
Pitched roof (cold)

A U-value of 0.16 can be achieved using 100 mm insulation between the joists and 150 mm insulation above the joists, with a thermal conductivity for both layers of 0.04 W/mK.

## Pitched roofs (warm)

- Ensure there is a tight fit between insulation boards and between the insulation and the adjoining structure.
- Fill all gaps with a sealant or expanding foam.

A U-value of 0.16 can be achieved using the thickness of insulation shown in the table below.



Pitched roof (warm)

Insulation thickness (mm) for 'warm' pitched roofs*		
Insulation $\lambda$ value	Between rafters	Over rafters
0.020 (foil-faced)	95	50
0.025	140	50
0.030	175	50
0.035	205	50
0.040	230	50

\*Assumes an air space behind plasterboard lining

## INSULATION STANDARDS AND CONSTRUCTIONS – WINDOWS

### WINDOWS

Double-glazed windows are now a normal component of all new housing, and should have a whole window U-value of 2.0 W/m<sup>2</sup>K or better. As the specification of windows by U-value can be complicated, it may be easier to specify windows by their frame and glazing combination rather than their thermal performance. There are many combinations of frame and glazing that will achieve the U-value of 2.0 W/m<sup>2</sup>K (see the table on the right for a selection).

Low-emissivity (low-e) coatings are of two principal types, known as 'hard' and 'soft'. The emissivity ( $\epsilon_n$ ) of low-e coating varies between  $\epsilon_n = 0.15$  and 0.2 for hard coat and  $\epsilon_n = 0.05$  to 0.1 for soft coat. If the emissivity of the low-e coating is not known the higher number should be used in each case. If the type of coating is not known a hard coat should be assumed.

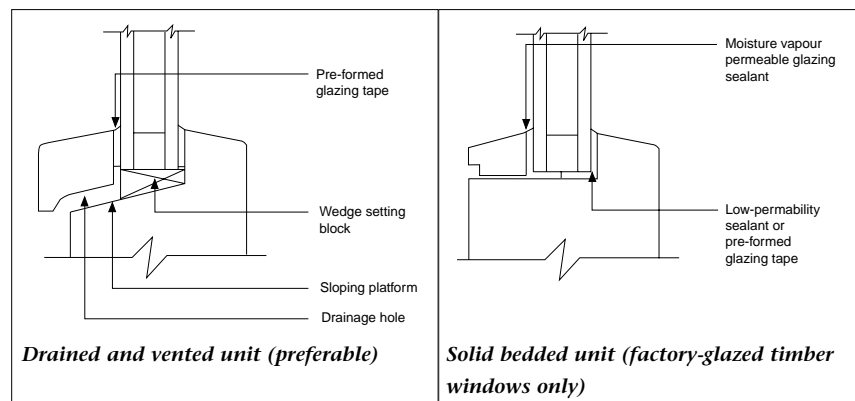
When available, manufacturers' certified U-values should be used in preference to the information given in the table.

It should be noted that different types of low-e glass may have slightly different optical characteristics. Careful records may need to be kept to ensure that different types are not mixed within a dwelling.

An enhanced standard can be achieved by filling the double-glazed unit with inert gas, that has a lower thermal conductivity than air (eg argon).

In addition to significant energy savings, which benefit the environment, low-e glazing also provides higher levels of thermal comfort because warmer internal surfaces reduce cold down-draughts and the sensation of 'cold radiation' from the glass.

Triple glazing is comparable to double glazing with low-e, but the addition of coatings and inert gases to triple glazing improves the performance beyond that achievable by double glazing.



Frame	Glazing	Coatings	Gas fill	Air gaps	U-value
Timber/PVC-U	Double	Low-e, hard (0.15)	Air	16+	2.0
Timber/PVC-U	Double	Low-e, soft (0.1)	Air	16+	1.9
Timber/PVC-U	Double	Low-e, hard (0.2)	Argon	16+	2.0
Timber/PVC-U	Double	Low-e, soft (0.1)	Argon	12	1.9
Timber/PVC-U	Triple	None	Air	16+	2.0
Timber/PVC-U	Triple	Low-e, hard (0.2)	Air	12	1.7
Metal (4 mm thermal break)	Triple	Low-e, hard (0.2)	Air	16+	2.0

\*Combinations of frame and glazing to achieve a U-value of 2.0 W/m<sup>2</sup>K

### EXTERNAL DOORS

Insulated doors that achieve a U-value of 1.0 W/m<sup>2</sup>K or better are readily available. Glazing units within such doors can be made to the same specification as for windows.

Insulated doors cost more than traditional timber entrance doors, but the cost difference can be small once decoration and fixing of ironmongery are taken into account.

### General design notes

- Choose high-quality frames, designed for the chosen double glazed units.
- Specify glazing techniques that provide adequate drainage and ventilation – only use solid bedding in timber windows if factory glazed.
- Seal around window and door frames with compressible sealing strips or expanding foam, while not interfering with any drainage paths.
- Specify that units should be fitted to BS 6262 in accordance with the Glass and Glazing Federation manual.
- Specify double glazing units that are Kitemarked to BS 5713.
- Due to the slightly different optical characteristics of low-e glazing, different types should not be mixed within a dwelling.

## 5 VENTILATION AND AVOIDANCE OF CONDENSATION

### THE NEED FOR VENTILATION

Due to the driving forces of wind and temperature, air infiltrates into and out of buildings through incidental openings in the structure, many of which are not easily visible once the dwelling is completed. The rate of infiltration depends on the leakiness of the dwelling, and the driving forces of wind and temperature at any given time. The level of airtightness achievable in a dwelling depends on factors such as:

- the type of wall and floor construction and the type of finish
- the level of detailing to avoid air infiltration
- the quality of windows and doors
- the level of workmanship and site control.

Consequently, the required ventilation in a home should be provided by purpose-designed openings which occupants can fully control, rather than incidental openings over which there is no control. Incidental openings can also be the cause of discomfort through draughts.

The aim should be to minimise the uncontrolled ventilation paths, and provide controllable ventilation.

### 'Build tight – ventilate right'

Effective ventilation should be provided to maintain air quality and remove moist air without unnecessary loss of heat. High humidity levels, combined with inadequate ventilation, can cause condensation and mould growth.

Average natural ventilation rates of between 0.5 and 1.0 air changes per hour (ach) are recommended for the whole dwelling. These air change rates can be achieved by using trickle vents in all window frames combined with extract fans or passive ventilation systems in kitchens and bathrooms. Whole-house ventilation systems with heat recovery can also be used.

If open-flued heaters which draw combustion air from the room are fitted, additional permanently open ventilation may be required. This ventilation should be as near as possible to the heater.

Approved Document J of the Building Regulations provides guidance on this issue.

## Housing associations

*Tenants should be advised on the need to maintain appropriate levels of ventilation in their homes to avoid condensation and mould growth.*

## Private developers

*High infiltration rates result in excessive heat loss and potential problems for the builder, including:*

- the inability of heating system to provide comfortable temperatures
- discomfort and complaints from occupants.

### General design notes

*Incidental air leakage should be reduced as follows.*

- Draughtstrip all doors and windows and the loft hatch.
- Seal around window and door frames with compressible sealing strips or expanding foam.
- Point window and door frames with mastic sealant.
- Seal joints between floors and walls.
- Use wet plaster in preference to dry-lining.
- Where dry-lining is used, seal at the perimeter on external walls.
- Seal around service pipes and cables where they enter the dwelling and ensure any ducting does not provide a ventilation path.
- Airtightness standards should be set and tested as described in this section.

## VENTILATION AND AVOIDANCE OF CONDENSATION

### EXTRACT FANS AND CONTROLS

Extract fans remove stale or polluted air from kitchens and bathrooms while fresh air is drawn in from other rooms, or from the outside through trickle ventilators and other openings.

All extract fans should preferably have a humidistat controller to keep the humidity in the room to an acceptable level, normally below 70% relative humidity.

Fans in bathrooms without windows should operate automatically on the light switch and not just run for 15 minutes after the light is switched off, but also operate on the humidistat controller. Fans should be correctly rated to avoid excessive ventilation.

### PASSIVE STACK VENTILATION SYSTEMS

Passive stack ventilation (PSV) is a system of vertical or near-vertical ducts that run from the kitchen and bathroom to vents on the roof. It reduces or eliminates the need for extract fans.

The ducts extract moist air (see diagram), and fresh air enters the dwelling through trickle ventilators and other openings.

The ventilation rate is regulated by humidity-controlled dampers which require no electrical connection.

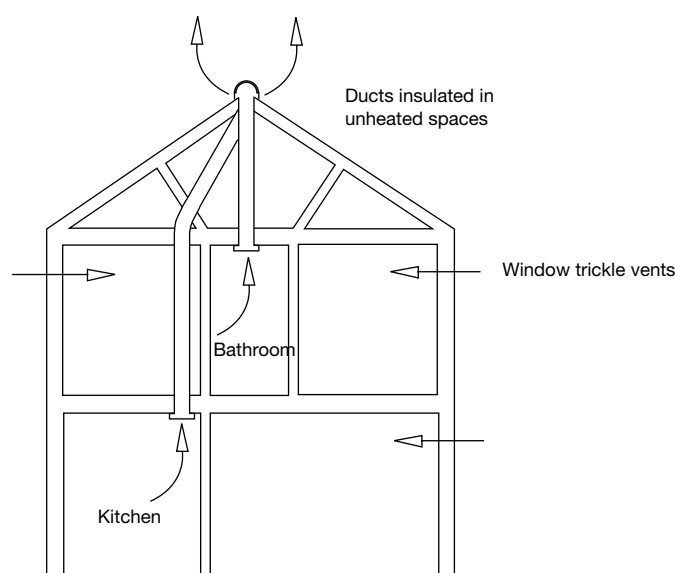
The peak ventilation rate is usually lower than for extract fans, but the PSV systems provides some continuous ventilation.

### General design notes

*For effective ventilation, extract fans should be fitted:*

- *as high as possible in the room*
- *as close as possible to the source of the pollution*
- *as far as possible from the source of fresh air*
- *in accordance with manufacturers' instructions.*

*Special provision is required if open-flued heaters are located in the kitchen.*



*Passive stack ventilation*

### HYBRID SYSTEMS

Hybrid systems use a mixture of PSV and extract fans. An example of this is the use of a cooker hood with fan downstairs and PSV upstairs. This reduces the need to conceal ducts rising from ground floors and prevents the possibility of night-time noise nuisance of extract fans.

### General design notes

- *Ducts should be as near vertical as possible (less than 45° from the vertical) to maximise the stack effect.*
- *Ducts passing through unheated spaces must be insulated.*
- *A separate duct is required for each room.*
- *Outlet ducts are placed on the ridge of the roof or level with it.*
- *Only components specially designed for the system should be used.*

## VENTILATION AND AVOIDANCE OF CONDENSATION

### WHOLE-HOUSE VENTILATION WITH HEAT RECOVERY

In whole-house ventilation systems, fresh air is distributed by a duct system throughout the dwelling with air extracted from kitchens, bathrooms, and WCs. A heat exchanger that uses the heat from the exhaust air to warm the incoming air is usually incorporated. Trickle ventilators are omitted. The success of the system relies on a well-sealed dwelling, and houses should be tested for airtightness, as described below.

Whole-house mechanical ventilation systems do not necessarily reduce overall energy costs because

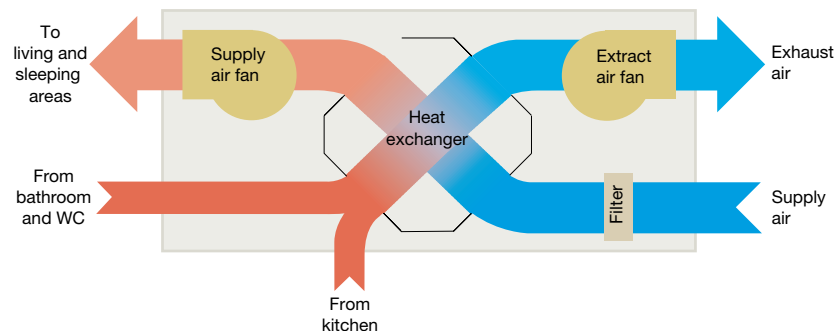
the use of on-peak electricity by the fan motors may offset the savings in space heating. However, they can significantly reduce the risk of condensation as long as they are not tampered with by a resident, and are regularly cleaned and checked. Failure of a full mechanical ventilation system can have serious consequences due to the lack of passive ventilation backup.

### PRESSURISATION TESTING FOR AIRTIGHTNESS

Because ventilation rates are very difficult to measure under normal conditions, a fan pressurisation test should be carried out on site to check that a new dwelling is sufficiently airtight. CIBSE has developed a recommended procedure for measuring the airtightness of dwellings as given in their publication TM23 (see Appendix A4 for details). This allows the results to be used for:

- ensuring consistent build quality
- comparing the airtightness of the dwelling with recognised standards
- identification of air leakage paths and the rate of air leakage
- measuring the improvement following airtightness work.

**Mechanical ventilation with heat recovery**



### General design notes

#### Fan pressurisation tests

- Dwellings with local extraction and trickle ventilators should achieve a target air leakage rate of  $5\text{--}7 \text{ m}^3/\text{hr}/\text{m}^2$  at an applied pressure difference of 50 Pascals (Pa).
- Dwellings with whole-house ventilation systems should achieve a target air leakage rate of  $4 \text{ m}^3/\text{hr}/\text{m}^2$  at an applied pressure difference of 50 Pa.
- It is suggested, as appropriate, that the first 10 houses of any new development (and following this a random sample of 1 in 10 built) should receive a pressurisation test as a quality control check.
- In the event of the standard not being met, remedial work should be carried out to all 10 units and two further properties in the set tested at the contractor's expense. The procedure should be repeated until the standard is achieved.

## 6 SPACE HEATING AND HOT WATER

### SYSTEM REQUIREMENTS

Space heating is needed to warm a dwelling from cold and to supplement the heat gains from the sun, the occupants, the hot-water system, cooking and electrical appliances.

The requirements of an energy-efficient heating system are:

- to warm the dwelling from cold to the required comfort temperatures within a reasonable time (normally one hour)
- to use fuel as efficiently as possible
- to be capable of control and thus provide heat only when and where needed
- to have controls that are easy to use and understand
- to be reliable and easy to maintain.

A highly efficient heating system will reduce running costs and can be used as a marketing feature.

Hot water can be heated from the heating system or from a separate source. It must be controlled to eliminate energy waste and, if stored, the cylinder must be well insulated.

### FUEL CHOICE

The choice of fuel may depend on availability, running costs, capital costs and CO<sub>2</sub> emissions.

Electric storage-heating systems have typically the lowest capital cost. To minimise running costs, capital cost savings should be invested in further energy efficiency improvements.

Natural gas, where available, is normally chosen as the fuel for wet heating systems.

Liquefied petroleum gas (LPG) and oil can both be used where natural gas is unavailable. Oil will provide lower running costs than LPG. LPG running costs are similar to those of off-peak electricity. Both systems require storage tanks. Siting restrictions are more stringent for LPG, although the tank can be installed below ground.

Coal-fired boilers with appropriate coal storage facilities can also be used where natural gas is unavailable. They are less responsive and require regular maintenance (fuelling and de-ashing) by occupants.

### WET CENTRAL HEATING SYSTEMS

A natural-gas-fired wet central heating system is usually the best option for two-bedroom or larger homes, if every room is to be heated. The boiler heats water for space heating and hot water. The energy efficiency of the system will depend on the choice of boiler, hot-water storage, if any, and the control system.

The recommended heating packages are the 'best practice' standards HR2 and HC2, taken from Central Heating System Specification (CHeSS). More information on CHeSS and recommendations for other fuels is available in General Information Leaflet 59.

### General design notes

*To determine CO<sub>2</sub> emissions in kg for each fuel, multiply the metered/billed fuel in kWh by:*

- 0.19 for natural gas
- 0.27 for oil
- 0.31 for solid fuel
- 0.42 for electricity\*
- 0.03 for biomass

*\*This is an average. Actual emissions depend on generation mix.*

Natural gas system	Regular system (CHeSS – HR2)	Combi system (CHeSS – HC2)
Description	Regular boiler and separate hot water store	Combination boiler or CPSU boiler
Boiler	SEDBUK efficiency of at least 82% (Bands A to C)	
Hot water store	High-performance hot water cylinder	None – unless included within boiler
Controls	Programmable room thermostat with domestic hot water time control	Programmable room thermostat
	Cylinder thermostat	N/A
	Boiler interlock	
	TRVs on all radiators except in rooms with room thermostat	
	Automatic bypass valve (where bypass circuit needed)	

*CHeSS HR2 and HC2 for gas systems*

## SPACE HEATING AND HOT WATER

### BOILER TYPES

The boiler heats water for space heating and hot water. Newer boilers can have a balanced flue which allows fresh air to enter the boiler, and flue gases to escape, direct through the external wall.

#### Gas condensing boilers

Condensing boilers are highly efficient boilers that use a larger heat exchanger area to extract more heat from the flue gases. They are always more efficient than non-condensing boilers even when they are not in 'condensing mode'.

#### Sealed systems

The space-heating system can be 'sealed' or unvented (avoiding the need for a feed and expansion tank). The system requires an appropriate boiler, special safety controls, and annual maintenance to check and repressurise. The sealing of the system does not contribute to the energy-efficient running of the system.

#### Combination boilers

Combination systems eliminate both the hot-water cylinder and the feed and expansion tank. Mains pressure hot water is supplied direct from the boiler on demand, the central heating being cut off automatically. Although the hot water will never 'run out', flow can be slow compared with a storage system. Whole-system costs are similar to a conventional system with stored water. Combination boilers are appropriate in smaller dwellings with minimal distribution pipework for the hot water service.

### PLUMING OF CONDENSING BOILERS

The plumbing of the water vapour in the exhaust from a condensing boiler is normal and results from the high efficiency at which the boiler runs. However, this characteristic should be explained to tenants or owner-occupiers. Care should also be taken to ensure that the plumbing does not cause a nuisance, eg avoid plumbing over footpaths or neighbouring property.

### ELECTRIC STORAGE HEATING SYSTEMS

Where electric storage systems are used in smaller dwellings and where there is no gas connection, off-peak electricity costs can be comparable with those of gas, due to the additional standing charges and maintenance costs associated with gas systems. Insulation standards are recommended at 'level two' for any dwellings heated by storage heaters.

#### Recommended energy-efficient package

- Fan-assisted off-peak storage heaters with top-up on-peak convectors, in living-rooms.
- Storage heaters in large bedrooms and large kitchens.
- On-peak fixed convector heaters with time switches and thermostats in small bedrooms.
- On-peak, down-flow heaters in bathrooms and small kitchens.
- Automatic charge control and thermostatically controlled damper outlet on all storage heaters.
- 210-litre, dual-immersion cylinder for hot water with factory-applied insulation.
- Hot-water controller with one-hour on-peak boost facility.

### ALTERNATIVE HEATING SYSTEMS

#### Individual gas room heaters in conjunction with an instantaneous water heater

Due to the small heat losses of energy-efficient new housing, two or three room heaters can often supply sufficient heat to the whole dwelling. Capital costs are low, but layout and design must ensure adequate heating throughout the dwelling.

#### Warm-air heating, stored hot water

For small, well-insulated dwellings, warm-air heating (comprising heat generator, ducts, and fans) is a simple option. Careful design is needed for good heat distribution and a unit that supplies both space and water heating is required.

#### Alternative electric systems

On-peak electricity for space or water heating will always be costly, except where demand is extremely low. Central off-peak electric storage systems (water

## SPACE HEATING AND HOT WATER

or brick) are costly to install and are unlikely to give low running costs. Electric heat pumps for space heating, in conjunction with whole-dwelling ventilation systems with heat recovery, can provide low running costs, although outputs are generally limited to approximately 5 kW. Additional output can be provided by electric or gas heater elements that are more costly to run than the heat pump.

### Communal systems

Group, district, community or combined heat and power (CHP) heating systems can be installed in most new developments. However, consideration should be given to metering, maintenance and management arrangements.

A number of small-scale residential CHP schemes are already in operation in the UK. The environmental benefit of using small-scale CHP is that its high energy efficiency results in reduced CO<sub>2</sub> emissions. On smaller developments, consideration should be given to the location of CHP plant to avoid noise pollution for residents in its immediate vicinity.

### Solar water systems

An active solar water system can supplement, but not replace, a conventional water-heating system. Payback periods are generally in excess of 15 years.

### EFFICIENT DESIGN OF HEATING SYSTEMS

Heating systems must be large enough to meet reasonable maximum demand. However, oversizing will lead to inefficient operation as well as unnecessary capital cost. The following factors should be considered in the design of well insulated homes.

- Ventilation heat losses take up a greater percentage of the total heat loss and need to be well controlled to maintain comfort conditions.
- The size of the boiler will be dependent as much on hot water requirements as on space-heating demand.
- The system should be designed accurately to the design temperatures in BS 5449 (see appendix A2).

### Zone controls

- Allow two or more zones within larger houses and provide a separate time and temperature control for each.
- Generally, these zones will be for upstairs and downstairs, but in a house designed for passive solar gain they might be for north- and south-facing rooms.

### Weather compensators

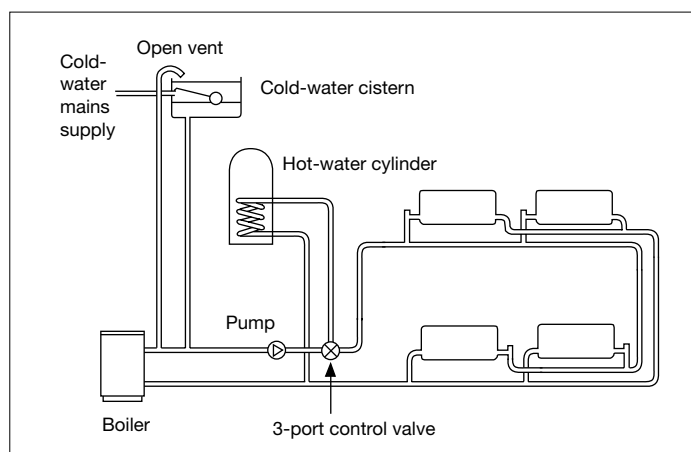
- Weather compensators regulate the temperature of the hot water flowing through the radiators to compensate for external changes in temperature.
- Compensators need to be sited in appropriate positions and be fully maintained to provide the greatest returns.

### Storage heater controls

- Automatic storage heaters have a thermostat to govern heat output/storage during off-peak and on-peak times.
- A room temperature thermostat switches off the core extract fan when the room reaches the required temperature.
- The convector control is wired to the thermostat so that it will come on only when the stored heat has been largely used up.
- An external timer controls both the core extract fan and the convector.

### General design note

*A good control package will optimise the running of the heating and hot water system.*



*Open-vented heating system with hot-water cylinder*

## 7 ENERGY-EFFICIENT LIGHTING AND APPLIANCES

### General design notes

Where appliances are not to be supplied, designers should:

- provide a gas point for cookers (the cost of gas cooking is less than that of electric cooking)
- provide a gas point for a tumble dryer and provide both hot and cold water supplies for washing machines or dishwashers
- provide information for tenants or owner-occupiers on the choice and use of efficient appliances.

### REDUCING CONSUMPTION AND COST

Electricity consumption for lights and appliances (including cooking) in an energy-efficient dwelling can cost around twice as much as space heating.

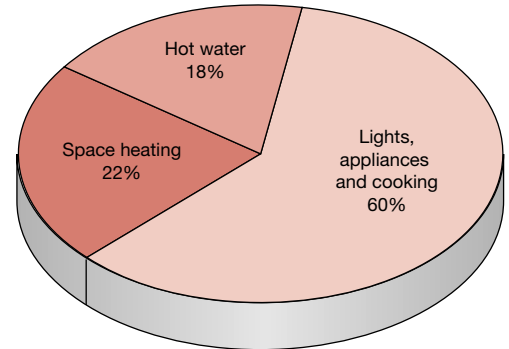
The designer can reduce this cost by:

- ensuring good daylighting to all areas
- specifying energy-efficient lamps, and switches at all room exits
- encouraging cooking by gas if gas is already available in the dwelling
- specifying or choosing low-energy appliances
- providing information on the choice and use of lights and appliances.

### ENERGY-EFFICIENT LIGHTING

Estate and all communal lighting should be controlled by time switches, photoelectric units, push-button controls, or passive infrared (PIR) detectors, as appropriate. Low-energy tubes or lamps should also be used (except where push-button time delay switches or PIR are to be used).

Compact fluorescent lamps (CFLs) are available in a wide range of types and lighting outputs. They can provide the same levels of illumination as conventional tungsten filament bulbs, however they are not suitable for use with conventional dimmer switches.



Relative costs for an energy-efficient house

Fittings designed specifically for CFLs should be specified where appropriate, thus ensuring that only CFLs can be used as replacements, and that the life of the control gear is preserved. Replacement CFLs for this type of fitting are significantly cheaper than conventional CFLs.

CFLs should be specified in all high-usage areas such as living-rooms, study/bedrooms, halls and landings.

Compact fluorescent lamps:

- can be fitted into conventional bayonet fittings
- use around 25% of the energy of tungsten lamps and last five times as long.

Fluorescent tube lighting is also more efficient than tungsten lighting and can be successfully used in kitchens, corridors, workshops, and garages.

'Slimline' tubes (T8) will give additional energy savings of around 5-10% over larger diameter tubes. High-frequency ballasts avoid flicker and provide an additional 5-10% savings.

### HOUSEHOLD APPLIANCE LABELLING

Where fridges, freezers, washing machines or tumble dryers are to be supplied, choose energy efficiency labels indicating an 'A' or 'B' energy rating. An 'A' rated appliance uses up to half the electricity of a similar 'G' rated model.

Eco-labelling is a voluntary scheme applying to washing machines, refrigerators, lightbulbs and a variety of household goods. It indicates that a product has passed tests that relate to its impact on the environment.

Energy		Washing machine
Manufacturer Model		
More efficient	A B C D E F G	B
Positional only		
Less efficient	A B C D E F G	
Energy Consumption kWh/cycle (based on standard test results for 60°C cotton cycle)		1.27
Actual consumption will depend on how the appliance is used		
Washing performance A: higher B: lower	A B C D E F G	
Spin drying performance A: higher B: lower	A B C D E F G	
Spin speed (rpm)		1300
Capacity (cotton) kg		5.5
Water consumption l		75
Noise (dB(A) re 1 pW)	Washing Spinning	
Further information is contained in product brochures		
New EN 60484 Washing Machine Label Directive 95/10/EC		

## 8 ADVICE FOR RESIDENTS IN ENERGY-EFFICIENT HOMES

A resident who does not know how to control and operate the heating system is likely to waste energy and also be uncomfortable. Many people have difficulty setting or resetting time switches; trickle vents above windows are sometimes sealed, extract fans are not used and temperatures set too high.

The following actions will help residents derive maximum benefit from their energy-efficient home.

- Supply all new residents with a purpose-designed leaflet on how to run their homes in an energy-efficient way.
- Ensure face-to-face advice is given by a trained representative.
- Give special training to one resident who can act as a local energy adviser.
- Check the settings of all systems and give energy advice to tenants as part of the first year defects inspection.
- Monitor fuel bills (with resident agreement) and, if required, advise residents on how they could reduce bills.
- Give advice on the benefits of energy-efficient lighting including the long-term value of investing in the more expensive CFLs.

### STEPS TO HELP RESIDENTS

- Specify a heating time switch that is easy to read and set, and has a default programme (which fulfils normal heating requirements unless changed manually).
- Locate the time switch where it is easily visible and accessible.
- Specify room and cylinder thermostats with the 'usual' temperature range clearly marked.
- If an electric immersion heater is fitted to the hot-water cylinder as a backup, it must have an adjustable thermostatic control and a light outside the cupboard indicating when it is in use. Poor control of immersion heaters can be very expensive.

A TENANT'S GUIDE TO **Affordable heating**

## Advice on heating systems

**GAS**

If you have a gas supply, gas should be your cheapest option for heating, cooking and hot water.

- For the living room a gas fire is cheaper than an electric heater, open coal fire or bottled gas cabinet heater.
- Gas wall convactor heaters have the lowest running cost of any kind of heater.
- Many people regard gas central heating as a 'luxury' and think it must be expensive to use. In fact it is a very efficient type of heating and is easy to control. If the controls are not used sensibly, running costs can be high – follow the advice on the right.

**ELECTRICITY**

and full time? It is well known which is the most expensive form of heating unless they have a back boiler. A room heater, although expensive to install, will make better use of the fuel.

electricity is heating gas, electricity.

be an economic method of heating, but in fuels.

raffin heater you must open the window slightly. Fumes and process need to escape to prevent a possible build-up of condensation.

**SOLID FUEL**

Open fires make poor use of fuel. They are among the most expensive forms of heating unless they have a back boiler. A room heater, although expensive to install, will make better use of the fuel.

**HEATING SYSTEMS**

Open fires make poor use of fuel. They are among the most expensive forms of heating unless they have a back boiler. A room heater, although expensive to install, will make better use of the fuel.

**HELPLINE**

For more energy efficiency advice... contact NEA, St Andrews House, 90-92 Pilgrim Street, Newcastle-upon-Tyne, NE1 6SD. Tel 0191 261 9677

For grants other than the Home Energy Efficiency Scheme... contact the Environmental Health Department of your local council.

For advice on tenant participation... contact the Tenant Participation Advisory Service, Brunswick House, Broad Street, Salford M6 5BZ. Tel 0161 745 7903

For advice on the efficient use of energy... contact your nearest Local Energy Advice Centre (LEAC) on Freephone 0800 512012

For services that the fuel industries provide... contact your gas or electricity supplier.

In case of disputes... contact your Gas Consumers Council or Office of Electricity Regulation (OFFER) – their addresses are on the back of your bill.

**Useful leaflets**... A number of free leaflets are available from the Department of the Environment at Blackhorse Road, London SE99 6TT. Tel 0181 691 9000 **691 9000**

## APPENDIX – FURTHER INFORMATION

Environmental performance is expressed on the following scale

Pass	●
Good	● ●
Very good	● ● ●
Excellent	● ● ● ●

### A1 ECOHOMES

EcoHomes – the environmental rating for homes – rewards those developers who improve environmental performance through good design.

The rating considers the broad environmental concerns of climate change, resource use and impact on wildlife, but balances these against the needs for a high-quality, safe and healthy internal environment. The issues assessed are grouped into seven categories:

- energy – operational energy and CO<sub>2</sub>
- transport – location issues related to transport
- pollution – air and water pollution (excluding CO<sub>2</sub>)
- materials – environmental implications of materials selection, recyclable materials
- water – consumption issues
- ecology and land use – ecological value of the site, greenfield and brownfield issues
- health and well-being – internal and external issues relating to health and comfort.

Credits are awarded where specific performance levels are achieved in each category. Various options are available to developers to gain these credits.

EcoHomes is designed to reward positive steps taken to improve the environmental performance of homes, steps that go beyond the statutory requirements.

For further details, contact the BREEAM office at BRE on 01923 664462 or visit the EcoHomes website [www.bre.co.uk/sustainable/ecohomes](http://www.bre.co.uk/sustainable/ecohomes)

### A2 DESIGN GUIDANCE FOR INDOOR TEMPERATURES

Design guidance for internal temperatures for domestic dwellings is available in BS 5449, 'Specification for forced circulation hot water central heating systems for domestic premises'.

### A3 ENERGY LABELLING ORGANISATIONS

The following companies are approved by the government to deliver SAP ratings and each offer training in the use of their energy-rating software.

#### Elmhurst Energy Systems Ltd

Elmhurst Farm, Bow Lane, Withybrook  
Nr Coventry CV7 9LQ  
Tel 01788 833386. Fax 01788 832690

#### MVM Consultants plc

Energy Division  
MVM House, 2 Oakfield Road, Bristol BS8 2AL  
Tel 0117 974 4477. Fax 0117 970 6897

#### National Energy Services Ltd

National Home Energy Rating Scheme  
The National Energy Centre, Davy Avenue  
Milton Keynes MK5 8NA  
Tel 01908 672787. Fax 01908 662296

### A4 BIBLIOGRAPHY

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## APPENDIX – FURTHER INFORMATION

ENERGY EFFICIENCY BEST  
PRACTICE PROGRAMME DOCUMENTS

The following Best Practice programme publications are available from BRECSU Enquiries Bureau. Contact details are given on the back cover.

**General Information Leaflets**

- 22 Passive solar house design – Barratt Study
- 25 Passive solar house designs – the Farrans study
- 31 Building Research Establishment Domestic Energy Model (BREDEM)
- 59 Central Heating System Specifications (CHeSS) – year 2000
- 83 Domestic boiler anti-cycling controls. An evaluation

**General Information Reports**

- 27 Passive solar estate layout
- 38 Review of ultra-low-energy homes. A series of UK and overseas profiles
- 39 Review of ultra-low-energy homes. Ten UK profiles in detail
- 53 Building a sustainable future. Homes for an autonomous community
- 64 Post-construction testing – a professional's guide to testing housing for energy efficiency
- 72 Heat pumps in the UK – a monitoring report
- 88 Solar hot water systems in new housing – a monitoring report

**Good Practice Case Studies**

- 166 Energy Efficient Pattern Book Housing
- 340 Environmentally sensitive housing. Dallow Road, Luton

**Good Practice Guides**

- 199 Energy efficiency lighting – a guide for installers
- 268 Energy-efficient ventilation in housing. A guide for specifiers on the requirements and options for ventilation
- 284 Domestic central heating and hot water: systems with gas and oil-fired boilers – guidance for installers and specifiers
- 293 External insulation systems for walls of dwellings
- 301 Domestic heating and hot water – guidance for installers and specifiers (in preparation)
- 302 Controls for domestic central heating and hot water

## **Energy Efficiency Best Practice in Housing**

Tel: 0845 120 7799

[www.est.org.uk/bestpractice](http://www.est.org.uk/bestpractice)

Energy Efficiency Best Practice in Housing is managed by the Energy Saving Trust on behalf of the Government. The technical information was produced by BRE.

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